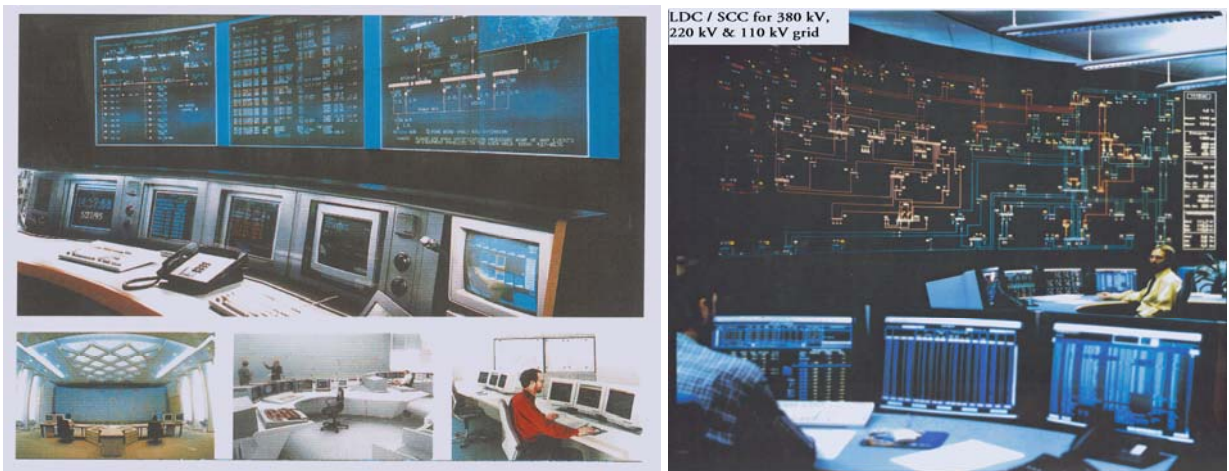


4.2 Supervisory & Control Centres (SCC)

SCC for UHV/HV/MV are the nerves centres of modern power utilities. Information from the network-process are transmitted to the SCC and commands are given from there to the network components directly or to the substation specified as single command or more common.

A hierarchy of SCC guarantees a fast and reliable electricity supply to the customers on all voltage levels.

Technical equipment and tasks for SCC in hierarchy different; overlapping information and/or reserve level are usual.



- all relevant information from the process "network" are available
- the information has to be indicated optically and acoustically, dependant to the importance, to support the work of the SCC staff
- information are ordered hierarchically because of the reaction time of SCC staff and the technical system
- staff has to stay day & night in the SCC
 - ergonomically designed work places are important
 - light must be adaptable; blinding effects have to be avoided
 - furniture must be practical, not only standard
 - contact with the environment necessary, concerning
 - weather by large windows
 - public events by broadcasting and TV
 - protection against noise and the direct access for everybody
 - climatisation of the SCC
 - kitchen and resting place
 -
- security and availability aspects
 - access control

- power supply redundant
- information lines redundant

Operational measures

* **undisturbed network** -> switching **on** and **off** for

- integrating new components
- maintaining measures
- renewing measures

➤ measuring information

- current
- voltage
- active power
- reactive power
- temperature
- pressure
-

➤ meter information from coupling points, big/important customers

➤ system information

➤ command information sent from the SCC to the substation

- switching commands
- adjustment commands
- desired value commands
- system commands

* **disturbed network** -> protection tripping

- **duration of disturbances in the network**

- > higher risk of a customer outage in (n-1) planned networks (now (n-0))
- > stress of elements by higher voltage

- **duration of customers interruption**

switching off -> initiated by tripping of protection relays together with circuit breaker or fuses (automatically)

switching on -> manually (delay time from event to action)
 automatically (complicated technique; expensive)
 remote controlled (useful for all tasks)

measured values -> current, active & reactive power, voltage, frequency, temperature, protection data,

indicating -> position of feeder switches in substation, network state, ...



S C A D A = Supervisory Control and Data Acquisition

- priority control of information transmission from substation to SCC
 - circuit breaker HV
 - protection information
 -
 - circuit breaker MV
 - protection information
 - ...
 - frequency
 -
 - step of temperature (range: green, yellow, red)
 - step of gas pressure
 -
 - load
 - current
 - voltage
 -

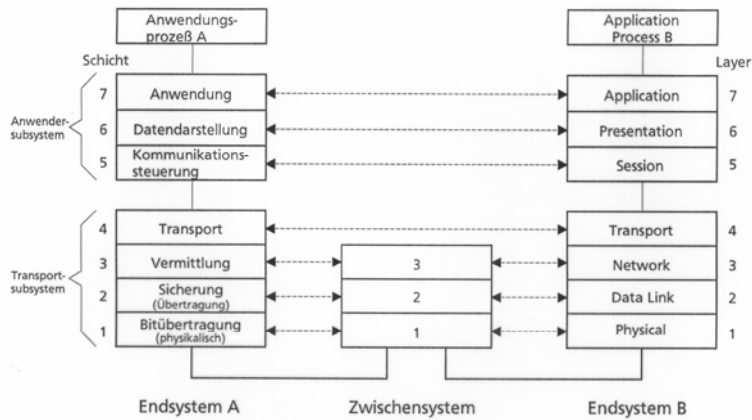
Software

- standard software, concerning the computer family
 - normally independent from SCC application
 - operation system (open systems) coupled with hardware system
UNIX for bigger SCC systems
Windows NT for smaller SCC systems; collects the functionality of VMS, UNIX, OS/2 and MS-DOS under a graphical surface
- network software
 - open systems allow to exchange data between different computer systems, simplification of ISO/OSI 7 layer model allows faster data exchange, ISO/OSI model simplifies the introduction and maintenance of new techniques and protocols
 - data exchange between substation and SCC are standardised by the telecontrol protocol IEC 870-5, between different SCC by the telecontrol protocol IEC 870-6
 - TCP/IP (Transmission Control Protocol / Internet Protocol) in 4 layers for the operation of communication networks

(1) application layer (OSI 5,6,7)

(2) transport layer

- (3) (IP) exchange layer
- (4) physical medium access



ISO / OSI reference model with end- and interjacent systems

- SCC specific software
 - communication between and co-ordination of different modules
 - queuing system (interface software) administer data exchange with data model; high requirements
 - operation software in distributed computer systems

- data model with access shells, representing the process/network components and data concern
 - * logically
 - * topologically
 - structure orientates on network structure
 - different storage of network elements, metering data, historical data, programs, ...
 - description of electrical networks e.g. from element, group, voltage level, substation
 - special language used for topology description
 - identical/compatible with that of the substation
 - * **primary functions**, necessary for the visualisation of the process in the SCC
 - * **secondary functions**, a higher information level as e.g. calculation of load flow, state estimation, short circuit current; modelling external networks, security analysis, network corrections, optimisation of load flow and reactive power, ..
 - * **operational planning**

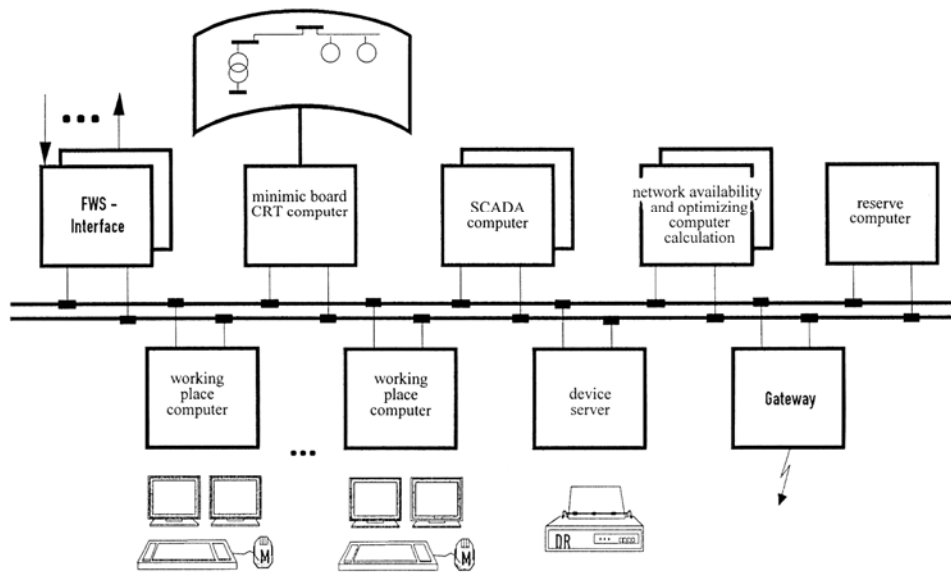
- * **Energy Management System (EMS)** (in a separate organisational unit)
- * **additional programs - computational intelligence**
 - experts system
 - Fuzzy logic
 - generic algorithm
 - neuronal networks
- * **service software**
 - support for picture construction: catalogue, self definition of elements, copies, logical connections, ..
 - taking over existing network data from the recent operational computer by a program

Hardware Configuration

1. generation : ~ 1972
 - processing computer with 192 kByte cpu
 - magnetic storage
 - punched cards
 - doubled system or hardware redundancy
 - I/O devices part of the specialised system

2. generation : ~ 1985
 - LAN (Local Area Network)
 - workstations
 - disks as shadow-sets operated
 - specialised processing computers
 - I/O devices connected to the LAN

3. generation : ~ 2000
 - distributed system
 - standardisation of the communication (7 layers of the ISO/OSI-model)
 - MMI (Man-Machine-Interface) offers a lot of functions
 - LAN
 - Token-passing-ring ~ 300 participants, ~ 2.000 m, 4...16 ... 100 MBd
 - Ethernet CSMA/CD 1024 participants, ~ 2.000 m, 10 .. 100 MBd
 - TCP/IP (Transmission Control Protocol/ Internet Protocol)
 - all 7 layers of ISO/OSI realised



Structure of a distributed system

Data output in the SCC

- mimic board – screen
- measuring instrument of important information as frequency, bus bar voltages, load of coupling transformers,
- diary
- warning announcement lists
- lighting the stations concerned on the control board showing automatically the station on the screen concerned
- showing the network status – galvanic connected lines in the same color
- different acoustical sounds
-

Requirements to new SCC systems

- timely unlimited adaptation to wanted performance with acceptable pains & costs
- high availability
 - fast data bus allows modular design
 - computers with high performance, used for special function calculation
 - easy to extent and to exchange hard- and software
 - less and easy maintenance
 - self documenting software in case of substation extension
- using
 - standardised software
 - standardised interfaces
 - upwards compatible software releases
 - application software modular and common used
 - self checking and fault diagnosis
 - changing protection parameters by telecontrol after changed network status

Low voltage network supervision

- about 85 % of power supply interruptions are caused by fault in the MV network, only about 15 % are created in the LV network directly
- most information by interrupted customers by telephone
- calculation of maximum load and load curve from annual electricity consumption; only a few measurements are necessary . High loaded (calculated) feeders are measured 1 .. 2 days during high load season.
- fuses dimensioned only for short circuit, not for overload
- "controlled overloading" is allowed for a short time
- customers concerned have to be informed, if it is planned to switch off lines
- mobile emergency generation sets are used if the interrupted energy is high or if sensitive consumers are not supplied
- max. interruption time 8 .. 12 hours; in most cases the line will be repaired without realising other auxiliary measures

Supporting tools for supervising the LV network

- telephone, radio, ..
- documentation of the LV network on the city map background in the LV SCC
- mobile staff equipped with cars: radio, fuses, grounding devices, map with lines and house connections (paper, micro fiches, direct wireless contact to the documentation centre, ..)
- stand-by of staff 24 h/day
- incoming information during out-of service-hours: telephone directed to MV SCC; information the stand-by staff